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Inorganic Particles of Agricultural Origin

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Substantial quantities of mineral silicates are used as carriers for agricultural pest control agents. Most of this material is applied by air dissemination, either dry or as a droplet spray. Therefore, pulmonary and gastric deposition of the mineral carriers (and active agents) will occur among pesticide application personnel and some proportion of the general population in the vicinity of pest control operations—to the extent that particle size of the disseminated material is below the critical 5μm respirable diameter. Furthermore, ingestion of particulates deposited on food crops may be expected as well as mineral finding its way into drinking water supplies. It has been found that the silicates widely used in America can contain three forms of asbestos, anthophyllite, tremolite, and chrysolite. Of these, anthophyllite and chrysotile have been found associated with a neoplastic outcome after many years of exposure. It is therefore proposed that comprehensive mineralogical investigation of pesticide carriers is warranted, including epidemiological and clinical study of formulation and application personnel as well as exposed nonoccupational populations.

This paper is based upon an appraisal of the possible occupational cancer risks of pesticide workers published previously *(1)*.

It is the purpose of the paper to speculate on the potential health impact of the substantial quantities of inorganic particles disseminated into the environment by agricultural pest control with dry carriers.

Table 1 shows data published in the annual U.S. pesticide reviews for the years 1965–1969 and covers the poundages of various mineral silicates produced for use as dry carriers of active pesticidal chemicals. The data were included in *(1)* to direct attention, for the first time, to the potentially high pulmonary loading and possible cancer risk from these mineral silicates on which pesticides are dispersed.

Table 1 shows that in 1969, about 374,000,000 lb of Fuller's earth, 107,000,000 lb of talc and soapstone, 55,000,000 lb of pyrophyllite, 51,000,000 lb of kaolin, and 4,000,000 lbs of bentonite were produced. Figures for fireclay and stoneware clay have not been available since 1965, when production was reported as 13,000,000 lb.

It is the combined total of talc, soapstone, and pyrophyllite, at roughly 160,000,000 lb, which holds the potential cancer risk, for it is known that these minerals can contain asbestos as anthophyllite, tremolite, and chrysotile. As long ago as 1942, Schultz and Williams *(2)* reported tremolite content of such material as running to 80%. However, asbestos content of trade preparations of pesticides on mineral carriers has apparently not been explored, nor has the cancer experience of the applicators of these substantial quantities of material.

In support of the speculations of this paper it is perhaps pertinent to emphasize that Selikoff et al. *(3, 4)* established the pulmonary carcinogenicity of asbestos in combination with cigarette smoking, from analysis of causes of death in a statistically secure cohort of workers handling the mineral. It was found that an excessive incidence of pulmonary neoplasms occurred after more than 20 years of exposure. Furthermore, gastrointestinal cancer rates were elevated among both cigarette and noncigarette

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Table 1. U.S. production of pesticide vehicles, dry carriers, and diluents (1965-1969).[a]

		Mineral silicates, lb × 10^{-3}					
Year	Petroleum oil, 10^3 gal	Fuller's earth	Talc and soapstone	Pyrophyllite	Kaolin	Bentonite	Fireclay, stoneware clay
1965	20,454	276,870	77,682	58,160	26,028	12,980	13,130
1966	20,118	379,516	72,898	50,898	48,202	13,954	Not available
1967	18,396	361,000	81,518	55,196	25,288	20,684	Not available
1968	9,282	296,404	77,478	Not available	19,910	9,642	Not available
1969	12,180	374,852	107,444	55,200	50,854	4,398	Not available

[a] USDA data *(19)*.

smoking workers. Additionally, pleural and peritoneal mesotheliomas, ordinarily of rarest occurrence, appeared to be asbestos-associated even in nonsmoking asbestos workers. Mesotheliomas have also been found in persons briefly or intermittently exposed, as for instance those living in households of asbestos workers or within a short distance from asbestos plants *(5, 6)*. It is perhaps directly significant to the dry carrier exposure of pesticide workers that Kleinfeld et al. *(7)* reported lung neoplasms in a small sample of talc mining and processing personnel at greater than expected levels, presumably due to the asbestos content of the talcs. The majority of the respiratory tract cancers were later found to occur in the workers exposed 15 to 24 years *(8)*. On the other hand, a recent study of the mortality to the end of 1968 of 1030 workers who had started work between 1936 and 1966 in an anthophyllite asbestos factory in Finland *(9)* showed that there was an excess mortality accounted for in part by cancer of the lung, bronchi, and trachea. The experience of this large cohort suggests that at least the anthophyllite exposure of pesticide workers may eventualize in a neoplastic outcome.

Asbestos aside, it was reported in 1972 *(10)* that mesotheliomas occur in rats exposed to extremely fine glass fiber. Also, Pott and Friedrichs *(11)* evaluated the carcinogenicity of a number of minerals by intraperitoneal injection into experimental animals last year and found that both fibrous glass and nemalite [fibrous $Mg(OH)_2$] induced abdominal tumors. Thus, the pulmonary load and perhaps also the gastrointestinal load produced by pest control with fibrous but non-asbestos-containing minerals may turn out to be carcinogenic or cocarcinogenic.

According to the U.S. Department of Agriculture *(12)*, roughly 85% of all pesticides are applied by air dissemination. Therefore, pulmonary and gastric deposition of the mineral carriers will occur widely among pesticide application personnel, as well as among some yet unknown proportion of the nonoccupational population in the general area around pest control operations. Of course, the particle size of the mineral carriers and the droplet size when water is used as diluent will influence the amount of the minerals deposited in the lung and ultimately the gastrointestinal tract.

It may also be important that in 1967, Windom et al. *(13)* found talc around 1% by weight in a series of atmospheric dust samples. These investigators attributed the source to local agricultural use.

The entry of pesticide-bearing mineral particles into the body, as related to agricultural pest control, is not limited to inhalation of airborne material. For instance, it is obvious that some proportion of the mineral carriers will be deposited on the crops being protected against pests and will ultimately be ingested in food. Also there will be ingestion from drinking water supplies into which the air-disseminated minerals may eventually find their way.

Since this has been stated to be a speculative paper, I would like to draw attention to a report recently published by Elespuru and Lijinsky *(14)* on the production of carcinogenic nitrosamines from a combination of nitrites with some alkylureas and alkylcarbamic acids used as pesticides. Additionally it suggests itself that as asbestos and benzo[a]pyrene are cocarcinogenic, at least in experimental animals *(15)*, asbestos and nitrosamines may also be. The role of asbestos or other mineral particles as cocarcinogens or carcinogen carriers has never been fully explored but it is the experience of some investigators that production of pulmonary carcinogenesis by benzo[a]pyrene in laboratory animals is facilitated when the chemical is carried on particulates such as ferric oxide *(16)* or in colloidal droplets *(17)*. However, nitrosamines, produced by the interaction of agriculturally ubiquitous nitrites and alkylureas or alkylcarbamic acids, may find their own way to the lung and gastrointestinal tract of exposed persons and be damaging, but it may ultimately be found that their contact with body organs is enhanced by an association with mineral particulates that also originate from related pest control.

Finally, attention is directed to a 1967 paper by Zolov et al. *(18)* in which asbestosis among Bulgarian agricultural workers is attributed to asbestos-containing soil constituents characteristic of a geological area that supported adjacent asbestos mining. This suggests that the working of some surface soils for agricultural purposes will also spread asbestos into the environment.

In conclusion, it seems reasonable to speculate that the dissemination of vast quantities of talc, soapstone, and anthophyllite each year in the United States may create a cancer risk, at least locally where pest control is carried out. Whether such is the case could of course only be established by examining trade preparations of pesticides for asbestos content by sampling related air, water, and agricultural products and by assembling cohorts of applicators and locally exposed nonoccupational persons for assessment in regard to cancer experience.

REFERENCES

1. Kay, K. Toxicology of pesticides: recent advances. Environ. Res. **6:** 202 (1973).
2. Schultz R. Z., and Williams, C. R. Commercial talc — animal and mineralogical studies. J. Ind. Hyg. Toxicol. **24:** 75 (1942).
3. Selikoff, I. J., Hammond, E. C., and Churg, J. Asbestos exposure, smoking and neoplasia. J. Amer. Med. Assoc. **204:** 106 (1968).
4. Selikoff, I. J., Hammond, E. C., and Churg, J. Mortality experiences of asbestos insulation workers, 1943–1968. Paper presented at International Conference on Pneumoconiosis, Johannesburg, 1969.
5. Newhouse, M. L., and Thompson, H. Mesothelioma of pleura and peritoneum following exposure to asbestos in the London area. Brit. J. Ind. Med. **22:** 621 (1965).
6. Wagner, J. C., Slaggs, C. A., and Marchand, P. Diffuse pleural mesothelioma and asbestos exposure in North West Cape Province. Brit. Med. J. **17:** 260 (1960).
7. Kleinfeld, M., et al. Mortality among talc miners and millers in New York State. Arch. Environ. Health **14,** 663 (1967).
8. Kleinfeld, M., Messite, J., and Zaki, M. H. Mortality experienced among talc workers: a follow-up study. J. Occup. Med. **16:** 345 (1974).
9. Nurminen, M. A study of the mortality of workers in an anthophyllite asbestos factory in Finland. Work - Environ. - Health (Finland), **9:** 112 (1972).
10. Stanton, M. F., and Wrench, C. Mechanisms of mesothelioma induction with asbestos and fibrous glass. J. Natl. Cancer Inst. **48:** 797 (1972).
11. Pott, F., and Friedrichs, K. H. Tumoren der Ratte nach I.P. - Injektion faserformiger Staube. Naturwiss. **59:** 318 (1972).
12. U. S. Dept. Agriculture, Agricultural Stabilization and Conservation Service. Pesticide Review, Washington, 1971.
13. Windom, H., Griffin, J. J., and E. D. Goldberg. Talc in atmospheric dusts. Environ. Sci. Technol. **1:** 923 (1967).
14. Elespuru, R. K., and Lijinsky W. The formation of carcinogenic nitroso compounds from nitrite and some types of agricultural chemicals Food. Cosmet. Toxicol. **11:** 807 (1973).
15. Miller, L., Smith, W. E., and Berliner, S. N. Tests for effect of asbestos on benzo[a]pyrene carcinogenesis in the respiratory tract. Ann. N. Y. Acad. Sci. **132:** 489 (1965).
16. Saffiotti, U., Cefis, F., and Kolb, H. A method for the experimental induction of bronchogenic carcinoma. Cancer Res. **28:** 104 (1968).
17. Henry, M. C., et al. Respiratory tract tumors in hamsters induced by benzo[a]pyrene. Cancer Res. **33:** 1585 (1973).
18. Zolov, C., Bourlikov, T., and Babadjov, L. Pleural asbestosis in agricultural workers. Environ. Res. **1:** 287 (1967).
19. U.S. Department of Agriculture; Pesticide Review 1970, Washington, D.C., 1970.